REMARKS

Upon entry of this Amendment, claims 1 and 3-20 will be all the claims pending in this application. Claims 1, 5-6, 10, 12-16 and 19-20 are amended. Claim 1 is amended to incorporate therein the recitation of claim 2, and claims 5-6, 10, 12-16 and 19-20 are variously amended to correct dependencies, to improve form and clarity, and otherwise as discussed herein. Support for the amendments can be found, *inter alia*, in the claims as originally filed. Entry is respectfully requested.

Applicants kindly request that the Examiner acknowledge receipt of Applicant's IDS filed February 1, 2007, and acceptance of the drawings.

Rejections Under 35 U.S.C. § 112

A. Claims 1 and 3-10 are rejected under 35 U.S.C. § 112, first paragraph. The Examiner believes that the limitation "carbon-doped titanium oxide having 0.3 to 15 at% of carbon" is critical or essential to the practice of the invention, and should therefore be included in claim 1.

Applicants amend claim 1 to incorporate therein the recitation of claim 2. The significance of the limitation of claim 2 is given in paragraph [0023].

B. Claims 5-6 and 13-15 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite in that the positions of the layers are said to be unclear.

Claims 5-6 and 13-15 are amended to clarify the positions of the layers.

C. Claims 10, 19 and 20 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite as lacking antecedent basis for the term "the titanium alloy."

Claim 10 is amended to depend from claim 9.

In view of the foregoing, the claims comply with 35 U.S.C. § 112.

Withdrawal of the rejections are earnestly solicited.

The Claims Are Patentable Under 35 U.S.C. § 102

A. Claims 1-20 are rejected under 35 U.S.C. § 102(e) as being anticipated by Zhou et al (7,175,911) or Kaneko et al (6,839, 987) or Morikawa et al (6,794,065 or 6,743,749).

The Examiner takes the position that each reference discloses the claimed C-doped titanium alloy having the claimed amount of carbon therein (as claimed in claims 1 and 2). The Examiner further assumes that a Vickers hardness of 300 or higher (claim 3) is inherent in the references based on the amount of C-doping.

B. Claims 1-20 are rejected under 35 U.S.C. § 102(b) as being anticipated by McCurdy (6,238,738) or Sugiyama (6,306,343) or Khan et al ("Efficient Photochemical Water Splitting by Chemically Modified n-TiO2") or Sakthivel et al ("Daylight Photocatalysis by Carbon-Modified Titanium Dioxide").

The Examiner again takes the position that each foregoing reference discloses the claimed C-doped titanium alloy having the claimed amount of carbon therein. The Examiner assumes that the claimed hardness is inherent in the references based on the amount of C-doping.

Applicants respectfully traverse and amend claims 1, 5-6, 10, 12-16 and 19-20.

Claim 1 of the present invention, from which all claims except claim 11 depend, is characterized by having at least a surface layer comprising a carbon-doped titanium oxide layer, having the carbon doped in a state of Ti-C bonds, which is excellent in durability, and that functions as a visible light responding photocatalyst, wherein the carbon-doped titanium oxide layer contains 0.3 to 15 at% of carbon. Claim 11 also characterizes the carbon as being doped in a state of Ti-C bonds.

The carbon-doped titanium oxide layer having the carbon doped in a state of Ti-C bonds is produced only by specific heat treatment. The heat treatment needs to be performed such that the surface temperature of the substrate is 900 to 1,500°C, preferably 1,000 to 1,200°C, and such that a carbon-doped titanium oxide layer having carbon doped in the state of Ti-C bonds is formed as the surface layer of the substrate. In cases involving heat treatment wherein the surface temperature of the substrate is lower than 900°C, the durability of the substrate having the resulting carbon-doped titanium oxide layer is insufficient, and its photocatalytic activity under visible light is also insufficient. On the other hand, in cases involving heat treatment wherein the surface temperature of the substrate is higher than 1,500°C, a super-thin film peels off the substrate surface portion during cooling after heat treatment, and durability (high hardness, scratch resistance, wear resistance, chemical resistance, heat resistance) is insufficient. Even with heat treatment leading to the surface temperature of the substrate within the range of 900 to 1,500°C, a prolonged heat treatment time causes peeling of a super-thin film from the substrate surface portion during cooling after heat treatment, and durability (high hardness, scratch resistance, wear resistance, chemical resistance, heat resistance) is insufficient.

Thus, the heat treatment time needs to be a time which does not cause peeling to the substrate surface portion during cooling after heat treatment. That is, the heat treatment time needs to be long enough to convert the surface layer into a carbon-doped titanium oxide layer having carbon doped in the state of Ti-C bonds, but that does not cause peeling of the super thin film from the substrate surface portion during cooling after heating. This heat treatment correlates to the heating temperature, but is preferably about 400 seconds or less. (see paragraph [0039] of the present US Publication 2007/0040278Al).

The carbon-doped titanium oxide layer of the multifunctional material according to the present invention has a relatively high content of carbon, and contains doped carbon as Ti-C bonds, unlike chemically modified titanium oxide, such as that described in Shahed U.M. Khan et al., SCIENCE Vol. 297, September 27, 2002, p. 2243-2245, or titanium oxides containing titanium compounds Ti-O-X doped with various atoms or anions X, which have been proposed conventionally. As a result, its mechanical strengths such as scratch resistance and wear resistance are improved, and its Vickers hardness is considered to be markedly increased. Its heat resistance is also increased. (see paragraph [0042] of the present US2007/0040278A1).

As described above, the multifunctional material of the present invention is thus different from the materials disclosed in the cited references. None of the cited references expressly or inherently disclose the carbon doped in a state of Ti-C bonds and the heat treatment conditions for obtaining the carbon doped in a state of Ti-C bonds.

Withdrawal of all rejections and allowance of all pending claims are earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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